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## The Gender Gap in Math – Incorporating Gender Equity in the High School Mathematics Classroom

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The Gender Gap in Math – Incorporating Gender Equity in the High School Mathematics  
Classroom

Ryan Sullivan

California State University Monterey Bay

An Action Thesis Submitted in Partial Fulfillment  
Of the Requirements for the Degree of  
Master of Arts in Education  
College of Education

California State University Monterey Bay

May 2015

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The Gender Gap in Math – Incorporating Gender Equity in the High School Mathematics  
Classroom

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APPROVED BY THE GRADUATE ADVISORY COMMITTEE

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## **Abstract**

Researchers have been analyzing the difference in performance between female and male math students since it was first documented in the 1950s. The issue of male students disproportionately outperforming their female counterparts, also known as the math gender gap, has been studied extensively over the last few decades with researchers attempting to understand what contributes to math gender gaps and how they can be closed. This study examined the current state of the math gender gap, how teachers incorporate gender equity into their practices, and the attitudes and beliefs of students in relation to math by conducting a three-part classroom action research study. To gain greater insight into the issue, four high school classrooms were observed for a period of four weeks, teachers were interviewed regarding to what extent they take gender equity into account, and a post-observation, affective survey was given to the students. As most of the reports on the issue base their conclusions on standardized test data, it was hoped that conducting an in-the-field, classroom study would provide more insight into the root causes of the gender gap as well as what concrete steps educators, students, and the public at large can take to help bring about greater gender equity in mathematics. The study finds that while progress has certainly been made in regards to gender equity in math, some of the traditional inequitable patterns persist and that teachers can help create a more equitable situation by incorporating gender equity into their daily routines and practices.

## **Acknowledgements**

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The participating teachers and students were very kind to invite us into their classrooms. Without their help, this research would not have been possible. I thank them for both allowing me to be an objective observer in their classroom and for sharing their perspectives and experiences in the survey portion of the study.

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## **CHAPTER 1: Introduction**

The gap of performance between male and female students in mathematics is a subject that has been of increasing concern in the United States ever since it began to be measured and studied in this country during the 1950s to 1960s (Sohn, 2012). Over the last few decades, educators and others have worked to close this gap through various strategies including the recruitment of female students into math programs and fighting through the stereotypes and opinions often held by the public that serve to perpetuate the difference in performance (Fryer and Levitt, 2009). In order to facilitate this goal, efforts have been made to understand what factors contribute to and exacerbate the inequity of the math gender gap. However, there is still little consensus on this issue. So far, it seems as if there may be a complex array of various factors at play, all making some impact toward the gap. As to how much of an impact particular factors make remains to be answered. Besides a lack of consensus about the causes of the gender gap, researchers also disagree as to whether the gender gap is even a problem at all, some going even so far as to claim the gap is now virtually nonexistent (Hyde, et al., 2008). This study seeks to synthesize the existing literature on the subject in order to add clarity to the topics of identifying the contributing factors as well as to what extent the gender gap actually exists currently. Besides looking into the literature to gain such insight, action research at the classroom level, wherein discourse between female and male high school math students undergoes an intense level of examination, provides practitioners with needed insights into interactive patterns and potential bias and unintended discrimination. By gaining a better understanding of the gap and its contributing factors through action research, this project seeks to provide guidance as to what concrete steps can be taken by educators, students, and the public at large to help minimize the gender gap in American math students.



## **Problem Statement**

For as long as the performance of American math students has been recorded, educators have found that male students, on average, consistently outperform their female counterparts (Sohn, 2012). There have been a variety of explanations for this discrepancy. Some have posited that male students are genetically predisposed to do better in math (Fryer and Levitt, 2009). In this view, the naturally occurring differences between male and female brains give male students an advantage in math while giving female students advantages in other areas. Many other researchers have rejected this idea (Campbell and Beaudry, 1998). They would say that while male and female students do indeed think differently, female students have just as much capacity to do well in math as the male students (Valentine, 1998). Such researchers claim the problem here is that the type of thinking that the female students contribute is not recognized or rewarded in our current educational system. So, part of the inequity in math performance is related to the design of instruction and assessments that are geared towards male learners (Valentine, 1998). Most educators who reject the biological explanation of the gender gap in math performance also point out the wide variety of social and cultural factors that contribute to better performance for male students (Campbell and Beaudry, 1998). Teacher and familial expectations, availability or lack of role models, and biased classroom practices are just some of the many factors that are currently being analyzed in order to develop ways to counterbalance their effects.

If female students truly do have as much potential to succeed in math as male students, as most educators would profess to believe, we are wasting the opportunity to tap into their strengths. As most female students do not choose to pursue majors or careers in math and math-related fields, the economy and society as a whole suffers from not living up to its fullest potential. If the strengths of female math students were more consistently recognized and

rewarded, there would be a greater pool of educated professionals in the field. This pool would not only be bigger but arguably of better quality as it would include more diverse types of thinking (Valentine, 1998). Therefore, there is a need analyze the impact teachers have on female high school students pursuing mathematics and likewise the opposite effect of discouraging these students from such as pursuit.

This thesis study seeks to document the current state of the gender gap in the performance of American math students in order to identify what causes and perpetuates the gap. By better understanding its contributing factors, it is hoped that suggestions can be made to students, teachers, and families regarding what they can do personally to minimize the current inequity in math performance among American students.

## **Purpose**

As this is an action thesis, it seeks not only to inform readers but also to affect change – both directly and indirectly. First of all, it is hoped that the information provided here will raise awareness of the issue of math-related gender gaps and correct some of the common misconceptions regarding the issue. By synthesizing the available data regarding the issue and disseminating this information to educators, students, and the public, it is hoped that more will be aware of the facts surrounding the issue and the need to keep a close watch on it despite some promising recent studies. Another goal of this study is to add to the research on gender gaps by sharing the results of a study of four high school classrooms. While most of the available research focuses on standardized test scores, this study attempts to take a deeper look at the classroom level by including observation data, student survey responses, and interviews from the four teachers whose classrooms were observed. The observations sought to see if any of the behaviors and interactions researchers have found to be detrimental to gender equity are

prevalent in the classroom. The survey was used as an attempt to gauge the perspectives of the students on the issue of gender and math. Using the results of the survey can show how the students of today compare to those surveyed in the past. The interviews were given to investigate to what extent the teachers are conscious of gender equity and how much it affects their classroom structure and practices. The use of three different perspectives on the issue (those of the observer, students, and teachers) helped to frame the issue with a wider lens and hopefully minimize the bias of any one perspective.

### **Researchers Background**

I have been a math teacher at the high school level for twelve years at a large public, co-ed high school. I have taught most all of the levels of math our school provides from remedial math to AP Calculus. One of my primary goals as an educator has always been to ensure that all students achieve their highest potential and that school prepares them fully for future courses of study or careers. Despite this hope, I have seen over the years that the learning outcomes for particular groups of students are different. Gaps in achievement have been consistently found at our school depending on a student's sex, ethnicity, socio-economic status, and other factors. Although it has recently been shown that the gender gap in math has been gradually shrinking in the primary and secondary grades, I believe that the relatively large gap in male and female students pursuing math-related degrees and careers is a huge problem that will only get better if we keep our attention of this issue.

### **Theoretical Model**

There are a variety of competing theories that attempt to explain what leads to differing performances among female and male math students. While some have gained or lost popularity over the decades, they are all still alive in the debate to some extent. The oldest (some would say

most outdated) of these theories is the idea that gender related performance gaps are due to biological differences between females and males (Benbow and Stanley, 1983). Researchers arguing for this theory believe that there are actual physiological differences in the brain anatomy of females and males, specifically in the part of the brain that sets limits on one's potential math intelligence, and that this limit is higher in the male type of brain. This idea has been expressed in the sentiment that men are "wired to do math" where women are not. While cognitive theorists have been able to successfully document how gender related differences in brain structure lead to different ways of thinking for females and males, many researchers and educators call into question the idea that different ways of thinking can be equated with different potentials for success in mathematics (Valentine, 1998). Many researchers have attempted to refine this idea of cognitive differences (Campbell and Beaudry, 1998). While most would agree that the gender related different ways of thinking are undeniably well-documented, many modern educators are putting forth the idea that both types of thinking have the same potential for success (Valentine, 1998). In this view, the performance gap stems from the view that female ways of thinking are not nearly as recognized, practiced, and rewarded in schools as the ways of thinking of their male counterparts. If the design of instruction and assessment was changed to honor both ways of thinking equally, female achievement in math would be more commonplace (Reis, 2008).

While the cognitive theorists may highlight the need for redesigning educational materials and practices to improve gender equity, most researchers seem to see this as only one piece of a much bigger puzzle to be solved. Rather than focusing on biological differences, these researchers point to the wide array of social and cultural factors that contribute to differing performances among female and male math students. Using a theoretical framework often

referred to as the *differential socialization paradigm*, these researchers attempt to describe to what extent factors such as parental involvement, prior math achievement, socio-economic status, mathematics self-concept, and teacher expectations contribute to the gender gap in math performance (Campbell and Beaudry, 1998). Through the dissemination of the results of these studies, it is hoped that educators, families, and students will become more aware of their effects and change their habits and practices in ways that enhance equity. The differential socialization theory has gained much more exposure in the last couple of decades in comparison to discussion of cognitive differences. This theory can be seen as a productive, logical step in the right direction - changing social norms may be difficult, but changing one's genetics is as of yet impossible. As with many discussions of what creates success, the debate over gender differences in math performance often breaks down to whether success is due to one's environment, one's genetic make-up, or some combination of both - the classic, nature vs. nurture debate.

The debate over the root causes of the gender gap in mathematics has been going on for so long that researchers have developed a few theories specific to the topic of math-related gender gaps (Else-Quest, 2010). In general, those who subscribe to the differential socialization theory agree with what is called the *gender similarities hypothesis*. This is the view that males and females are similar on most, but not all, psychological barriers (Else-Quest, 2010). Therefore, they have equivalent capacities for success in mathematics and would perform the same if it were not for the social and cultural influences that lead to different outcomes. Researchers in this camp back up their view with findings that show the gender gap in American students has been shrinking consistently over the last few decades. They also point to international studies in which countries have been found where the gap is virtually non-existent.

Another theory specific to math-related gender gaps is the *greater male variability hypothesis*. While seemingly supportive of the cognitive theorists, it has actually received the attention of many who subscribe to the differential socialization paradigm as well (Hyde and Metz, 2009). The greater male variability hypothesis is based on several studies that show males having a wider spectrum of math intelligence. They have shown that most females are closer to the average math intelligence while there exist more males at the extremes of very high or very low math intelligence. Proponents of this theory believe genetic differences give males a broader range upon which their natural mathematical abilities can fall while this range is narrower for females. While this idea may be questionable, so far there is a lack of studies to refute it.

Also worth mentioning here is the *gender stratification hypothesis*. Several modern researchers have used this theory as the basis of their studies, usually in cross-national studies (Else-Quest, 2010). The gender stratification hypothesis is the idea that gender gaps in math performance are related to gender gaps in economic and educational opportunity. Basically, these researchers try to correlate gender inequity in math performance with gender inequity in general. Some of these studies have been able to show that greater social status of women in a country leads to greater equity in math performance. However, there have been some recent studies that seem to call this connection into question, showing that females perform equally or even better than males in some countries where women have much fewer rights and freedoms (Fryer and Levitt, 2009).

### **Research Questions**

- What can be learned from an analysis of the literature regarding the gender gap in math?
- What can be learned from an analysis of the various perspectives of those inside the classroom?

- Following an analysis of the body of research and the results of the classroom study, what implications can be drawn as far as potential changes that would help alleviate the gender gap in math?

### **Definition of Terms**

**Affective survey:** A survey that seeks to measure the appreciation, interests, and attitudes of participants (Leder&Forgasz, 2002).

**CCDA (Critical Classroom Discourse Analysis):** A modern method of studying classroom discourse and interactions which recognizes that classroom discourse is socially constructed, politically motivated, and historically determined. As such, CCDA seeks to collect data on as many facets of classroom discourse as possible and not just simple data such as frequency of speech (Kumaravadivelu, 1999).

**NCLB (No Child Left Behind):** The No Child Left Behind Act of 2001 is a United States Act of Congress that is a reauthorization of the Elementary and Secondary Education Act. The Act requires states to develop assessments in basic skills. To receive federal school funding, states must give these assessments to all students at select grade levels (No Child Left Behind Act of 2001, 2008).

**Likert scale:** Likert scales were developed in 1932 as the familiar five-point bipolar response that most people are familiar with today. These scales range from a group of categories—least to most—asking people to indicate how much they agree or disagree, approve or disapprove, or believe to be true or false (Allen & Seaman, 2007).

**STEM (Science, Technology, Engineering, and Math):** STEM stands for the four inter-related fields of science, technology, engineering, and math. STEM courses

have received a lot of attention in the past decade as the public have noticed that Americans as a whole do poorly in STEM compared to many other countries and that there is a significant gender gap in STEM fields (Hill, Corbett, & St Rose, 2010).

**Meta-analysis:** The process of synthesizing data from a series of separate studies. Meta-analysis has become a critically important tool in fields as diverse as medicine, pharmacology, epidemiology, and education (Borenstein, et al., 2011).

**Longitudinal study:** A longitudinal study is an observational study in which researchers do not interfere with their subjects. In a longitudinal study, researchers conduct several observations of the same subjects over a period of time, sometimes lasting many years (*At Work*, 2009).



## **Chapter 2: Literature Review**

When one reviews the literature on the math gender gap in the United States, many articles can be found on the subject dating back to the 1960s. While much has been written, there is a lack of consensus about how large these gender gaps are and at what ages they begin. There is also lack of agreement as to what causes and perpetuates the math gender gap. Part of this study was to synthesize the existing literature on the subject of math gender gaps by poring through many articles from the 1960s to the present while looking for common threads and agreement among the more prominent and respected researchers in the field. The goal here was to gain insight through the synthesis or at least get everyone up to date on the available data surrounding the issue.

### **History of Gender Gap Studies**

First, an attempt was made to get an idea of the history of studies on gender gaps. Studies documenting male students outperforming their female counterparts in math have been going on in the United States at least as far back as the 1960s. Many researchers in the field cite the seminal work *The Psychology of Sex Differences* by Maccoby and Jacklin as one of the earliest definitive studies of gender gaps in math performance (Sohn, 2010). This book collected 27 studies done during the 1960s and 1970s and documented a gap in performance that remained hidden in the lower grades but began to become more evident at the ages of 12-13 (Sohn, 2010). Since then, there have been several major studies into the issue of gender gaps in math that use a variety of available national and international data sets (Hyde et al., 2008; Hyde and Metz, 2009; Fryer and Levitt, 2009). While some researchers have used Scholastic Aptitude Test (SAT) scores in their comparisons, the validity of doing so has been called into question as these scores are simply a snapshot of student performance and do not allow researchers to follow the

performance of students over an extended period of time. Rather, they prefer to use longitudinal studies, those that make multiple observations of the same variables over a period of months or years. Most of the reports on the subject that have been published since the 1980s show very promising results.

Some of the most well-known and frequently cited of these studies have been done by Janet Hyde, a psychologist from the University of Wisconsin, along with a variety of her colleagues (Hyde et al., 2008; Hyde and Metz, 2009, Else-Quest et al., 2010). She conducted a meta-analysis of 16 studies in 1981 that showed a median effect size of -0.43, illustrating very little difference in performance (the research tools of meta-analysis and comparing effect sizes will be clarified in the upcoming section of this paper that discusses research methods and data). Another study published in 1990 by Hyde, et al. showed that the gap had narrowed even further. Using 100 sources, they found that the overall effect size for the general population was a mere -0.05, entering levels where it may be deemed insignificant. This study was followed up by another meta-analysis in 1995 that yielded results that were similar with effect sizes ranging from 0.03 to 0.26 (Hyde and Metz, 2009). Studies done around the same period using longitudinal data rather than meta-analyses confirmed the results of Hyde (Leahey and Guo, 2001). The consensus at this point was essentially that the gender gap in achievement had narrowed to almost insignificant levels and that it did not appear prominently until the middle school years at the earliest. Hyde and her colleagues have published more recent reports using data from the No Child Left Behind (NCLB) assessments that confirm the trend identified in their earlier studies. The gap is shown to be even smaller, so small that Hyde goes so far as to call it “erased” in some cases (Hyde et al., 2008).

In contrast to these findings, more longitudinal studies have been conducted recently that show slightly different results. Rather than appearing only as early as the middle school grades, researchers such as Fryer and Levitt have used the Early Childhood Longitudinal Study – Kindergarten (ECLS-K) to show that the gap can actually be seen to appear in the lower grades. Fryer and Levitt found that although there were no mean differences upon entering school, female students lost one-fourth of a standard deviation compared to males in the first six years of school (Fryer and Levitt, 2009). While these findings conflict with much of the older research into the topic of gender gaps, they are becoming more commonly accepted as other studies besides those of Fryer and Levitt are yielding the same results (Sohn, 2009).

### **Factors Contributing to the Gender Gap**

There have been many attempts to identify the root causes leading to the gender gap in math, for only by understanding its causes can we most effectively come up with solutions to remedy the situation. While quite a variety of such causes have been proposed, they can all be seen as falling into the areas of either biological factors or environmental factors.

Some researchers believe that there is a genetic difference between females and males that predisposes males to have superior mathematical abilities (Benbow and Stanley, 1983). They argue that there are physiological differences in the structure of the brains of female and male students that lead to the greater achievement in male students (Benbow and Stanley, 1983). As controversial as this idea is, there are widely available studies in the cognitive sciences that show how female and male students think quite differently and therefore should be expected to perform differently on various types of tasks. In such studies, male students score higher on spatial thinking tasks while female students perform better at particular verbal tasks (Dee, 2007).

The reason this aspect of the issue is so contested lies in how the results are interpreted. While female and males certainly have biological differences in general, their cognitive biological differences can be seen by some as leading to different ways of thinking and by some as leading to differences in ability or potential. It is the latter of these two that many find hard to accept. Rather than accept the questionable notion that females are not “wired” to do as well as their male counterparts in math, researchers have been attempting to understand the different ways of thinking between female and male students so that teaching techniques can be modified to best serve the needs of all, and authentic assessments can be created that won’t skew high achievement toward the males.

Another biological explanation for the gender gap is the Greater Male Variability Hypothesis (Else-Quest et al., 2010). The idea here is that male performance in math is naturally more stratified in both directions – that there are higher percentages of male students at both the higher and lower ends of the spectrum. Female scores are seen to more tightly cluster around the mean. While this aspect of the gender gap issue is also highly debated, there exists quite a bit of evidence in its favor, even evidence found by those researchers who typically explain gender gaps as originating from societal factors (Hyde et al., 2008). So, the overall average scores of female and male students could be equal, but at the same time there could be more male students in the highest and lowest performing groups. This distribution can explain why there seems to be a disproportionate amount of male students at the highest levels of achievement.

Rather than claim there to biological factors contributing to the gender gap, most modern researchers identify a host of environmental factors that can be shown to influence the math performance of female and male students (Campbell, 1998). Teachers’ and students’ perception of their skills, the design of the classroom environment and assessments, the presence or lack of

parental involvement, and the presence or lack of female math teachers and role models are just a few of the many environmental factors that can be seen to have an effect on the performance of female and male math students (Campbell, 1998). While clearly no one of these factors is the sole cause of disparity in performance, recent studies have attempted to systematically analyze these effects to understand how they interplay with one another to lead to different outcomes in performance (Campbell and Beaudry, 2001; Sohn, 2009).

It is clear that more research needs to be done to identify the various environmental factors leading to the math gender gap and to gain an understanding of their relative significance. This research will allow those attempting to affect change in this area to focus on the changes that will have the most significant outcome. By further analyzing the root causes of the math gender gap, a bridge can be built from research to practice through the dissemination of practical solutions to educators, families, and students themselves.

Once this is done, suggestions can be made for how schools, families, and educators may change their practices to provide a more equitable environment for female math students. There are already a good number of educational researchers providing such suggestions. Reis and Gavin, for example, in their book *Why Jane Doesn't Think She Can Do Math: How Teachers Can Encourage Talented Girls in Mathematics* provide a list of six strategies to help educators close the gender gap: providing a safe and supportive environment; assuming personal responsibility to encourage talented females; employing instructional strategies that address the characteristics of females; using language, problems, and activities that are relevant to girls; creating a challenging curriculum that promotes deep mathematical thinking; and providing female role models and mentors for girls (Reis and Gavin, 2008).

## **The Need for Further Research**

There are a multitude of reasons for further research into the history, causes, and remedies of math-related gender gaps. As mentioned previously, females are highly underrepresented in math-related college programs and in careers in STEM fields (Reis and Gavin, 2008). There is a clear failure on the behalf of the American education system - the potential of American female students is not being fully tapped into. Even though female students spend more time working on math and achieve higher letter grades than their male counterparts, they don't perform as well on standardized assessments and are quicker to give up their studies of math than male students (Reis and Gavin, 2008). As fewer female students do well in math, fewer of them decide to pursue college majors in science, technology, engineering, and math (STEM), and therefore, fewer female students end up in career fields that are math-related. In fact, even though females make up approximately 50% of filled jobs in the United States, they hold fewer than 25% of the STEM-related jobs (Scutt et al., 2013). This underrepresentation is problematic as Americans industries are often faced with a shortage of available workers who are proficient in STEM fields (Cappelli, 2000). Such industries must recruit workers with advanced STEM skills from other nations.

Another indicator that gender gaps need to be addressed in America is that when cross-national comparisons are done, many countries can be found with far narrower or even non-existent gaps (Hyde and Metz, 2009). Rather than place the blame on inherent biological differences and simply accept disparities, educators can seek to more fully understand how female ways of thinking can be addressed in school and redesign their lessons and assessments appropriately. The public at large and especially the families of students and those involved in

education can be made more aware of the variety of ways in which environmental factors such as expectations and stereotypes can feed and perpetuate gender inequities.

While there has been a lot of discussion on the topic of gender gaps, there is some disagreement on what their levels are and exactly when they begin to appear. There is also some debate over whether the Greater Male Variability Hypothesis plays any effect and to what extent biological and/or environmental factors contribute to the gap. Instead of focusing on the size of the gap and at what age level it appears, this paper will attempt to concentrate on the root causes of gender gaps and what specific, concrete, practical steps can be taken to move all students towards greater equity in education and beyond.

### **Classroom Discourse Analysis**

To prepare for the action research portion of this study, the literature regarding classroom discourse analysis was also reviewed, especially research pertaining to the study of verbal interactions in the math classroom. The theories and techniques in the field of classroom discourse analysis have been evolving for quite some time. Critical Classroom Discourse Analysis (CCDA), one of the more modern techniques used, is a method that takes into account the sociocultural nature of classroom discourse by collecting as many types of data as possible and attempting to see the “big picture” of a situation rather than limiting the focus to particular aspects of discourse (Kumaravadivelu, 1999). It was developed through the progression of previously prevailing discourse analysis techniques including the Flanders model, the COLT method, and strategies promoted by Allwright and van Lier. The commonly cited theories that underlie those techniques draw from the work of theorists such as Foucault, Said, and Spivak (Kumaravadivelu, 1999). A review of these theories reveals that they all have a common point – classroom discourse analysis should attempt to capture the interplay between what happens in

the classroom and the broader social and political forces that shape the interactions there.

Prominent researchers in the field of CCDA such as Kumaravadivelu, Baxter, and Johnson and Tannen call for discourse analysis that looks at much more than just the frequencies of specific types of interactions.

While certainly not enough, there has been some research specifically into discourse in the math classroom. This has helped the issue progress by identifying some of the inequitable behaviors and interactions that educators can keep an eye on. Jungwirth, one of the prominent researchers in this area, discusses five examples of such interactions in her study “Interaction and Gender – Findings of a Microethnographical Approach to Classroom Discourse” – what she calls “blocking the task-constitution”, “blocking the reference to knowledge outside mathematics”, “the too complete description”, “the concealing versus emerging of failure”, and “the argumentative insistence versus the authoritative insistence” (Jungwirth, 1991). Basically, these include teachers allowing male students to dominate discussions of problem solving strategy and connections to the real-world, teachers downplaying the failure of males or emphasizing the failure of females, and teachers having an argumentative but helpful tone with males who answer incorrectly as opposed to a more dismissive, authoritative tone with females giving an incorrect answer. The observational portion of this study looks for evidence of such interactions. Another prominent researcher in the field of classroom discourse as it relates to gender is British author Helen Sauntson. In her book *Approaches to Gender and Spoken Classroom Discourse*, she provides many good ideas for conducting thorough classroom discourse analysis and shares examples that use video and audio recordings. The point of the book is that, “combining different approaches to the analysis of spoken classroom discourse is more fruitful than relying upon a single approach” (Sauntson, 2012).



## **Studies of Affective Factors**

The literature was also reviewed regarding affective factors and mathematics education, specifically how such affective factors may vary by gender and how they can be measured with various survey instruments. A number of affective survey instruments were reviewed including the Mathematics Attitudes Scales (MAS), the Attitudes Toward Mathematics Inventory (ATMI), the Who and Mathematics Survey, and the Mathematics as a Gendered Domain Scale.

Established in 1976, the MAS, also called the Fennema-Sherman Mathematics Attitude Scales, is the most widely used and longest lasting survey regarding attitudes and mathematics.

Coincidentally, not only did Fennema help write one of the most popularly used affective math surveys, she is also a prominent publisher of research regarding the gender gap in math. The MAS sorts student responses into nine categories called scales in analysis. The Attitudes Toward Mathematics Inventory, developed by Tapia and Marsh, is an updated version of the MAS that simplifies the analysis by using six categories rather than the nine of the MAS (Tapia & Marsh, 2004). Both the Who and Mathematics Survey and the Mathematics as a Gendered Domain Scale were developed by Australian researchers Leder and Forgasz (Leder & Forgasz, 2002). They were designed specifically to replace the MAS while correcting some of its problematic items and slimming down its scales to six instead of nine like the ATMI. Following this review of instruments, the Who and Mathematics Survey was chosen for this study as it is one of the most modern surveys available, is simple to implement, and has yielded useful results in previous studies.

A review of the literature on math gender gaps reveals that while some progress has been made, much more research needs to be done on the topic. As the majority of the detailed studies this literature review found were from outside the United States, it is especially important that

more research be done with American students. Researchers may be getting better at measuring the size of the gaps and identifying their causes, but much more needs to be done in the area of finding possible remedies to the problem as its symptoms continue to persist.

### **Chapter 3: Methods**

Besides attempting to synthesize the existing research on the gender gap in math, this thesis also seeks to contribute to the growing understanding of what perpetuates the gender gap by conducting an action research study. The goal of this study is to gain further insight into what steps educators, policy-makers, and the public can take in order to ensure that the gender gap in math is minimized to its fullest extent.

#### **Overall Research Design**

Action research was chosen as the preferred model for this study for a several reasons. First, as the author is a current teacher in the field who has been established at the same school for over ten years, it was decided to take advantage of the opportunity for easy access to collecting data from a wide variety of math classes. Action research was an ideal choice for this thesis study as it is specifically designed for teachers who are continually attempting to improve their own practices. Not only is the author one of such teachers, but it is also hoped that the information gained from this data collection and analysis can help other educators improve their practices, help students learn how to better advocate for their own education, and help families learn how to better support the achievement of their children.

#### **Specific Research Plan**

As action research is inclusive of all types of data that may contribute to the findings of a study, both quantitative and qualitative data will be collected. The data collection will consist of three main parts – a collection of data regarding the quantity and quality of speech used in the classroom by each gender (a classroom discourse analysis), an affective survey that will be given to the students following this collection of data, and an interview with the teachers of each classroom observed in the discourse analysis.

**Setting**

The setting of this study is Steinbeck High School in Ag City, California (pseudonyms). The following information is taken from the school's district website and [www.city-data.com](http://www.city-data.com).

**Community.**

"Ag City" is neither small nor exceptionally large – it had a population of about 154,000 in 2012. This consisted of roughly 77% Hispanic/Latino, 14% White alone, 7% Asian alone, 1.6% Black alone, 0.3% Pacific Islander, and 0.05% American Indian alone. The population includes a significant number of recent immigrants from Mexico. The overall population is relatively young – the median resident age is 28.6 years. The median household income is around \$50,600. The town is situated in a valley near the central coast of California. The major industry by far is agriculture, as the city plays a major role in California's agricultural economy.

**School.**

"Steinbeck High School" is relatively large compared with most other high schools with an enrollment of approximately 2700 students. It is the largest of four public high schools in the city. Even though it is centered in the wealthier, more White part of the city, there are still significant numbers of Hispanic/Latino students and low income students. The student population is socioeconomically diverse with 40% of students receiving free or reduced lunch, compared with 63% in the district ([projects.propublica.org](http://projects.propublica.org)). There are roughly equal percentages of Hispanic/Latino and White students with small percentages of students of other races.

**Class.**

The research project was conducted in four classrooms at the school. In attempts to randomize the study, four different teachers were chosen instead of multiple classes with the same teacher and different types of math classes were chosen – a Trigonometry class, two Math

2 classes, and a Math 1 class. This ensured an adequate mixture of 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup>, and 12<sup>th</sup> grade students. The average class size was approximately 30 students.

## **Participants**

### **Students.**

This project utilized the entire class of students of the four other teachers as a convenience sample. All students in each class will have their dialogue documented and all students were given the survey. The composition of each class was as follows:

- Class A: 13 girls, 16 boys, 1 of whom is SPED and 4 of whom are ELLs; age range 16-18.
- Class B: 17 girls, 16 boys, 4 of whom are SPED and 6 of whom are ELLs; age range 14-16.
- Class C: 20 girls, 11 boys, 3 of whom are SPED and 3 of whom are ELLs; age range 15-17.
- Class D: 16 girls, 16 boys, 1 of whom is SPED and 4 of whom are ELLs; age range 15-17.

### **Teachers.**

As this is an action research project, the teachers were participants, too. This study involved both the author who is collecting the data as well as the four different participating teachers.

- The author is a White male with 13 years of teaching experience, the past 11 of which were at Steinbeck High School. He holds bachelor's degree both in science and mathematics and currently teaches Math 1 and Calculus AB.

- Teacher A is also a veteran teacher with 26 years in the district. She came to Steinbeck High eight years ago after being a middle school math teacher for the first portion of her career. The research project will be implemented in her Trigonometry class which is made up of students in their junior or senior year.
- Teacher B has been teaching for 18 years. He taught private school and then at one of the other high schools in the district before coming to Steinbeck High this year. So, he is also new to the school. He is one of the football coaches at the school and teaches Math 1 every period. Data will be collected in his Math 1 class, composed of mostly 9<sup>th</sup> and 10<sup>th</sup> grade students.
- Teacher C has been teaching math for four years now and is new to Steinbeck High School this year. Data will be recorded in her Math 2 class which is composed of mostly 10<sup>th</sup> grade students.
- Teacher D is a veteran teacher who had taught at Steinbeck High School for 19 years. He is a graduate of Steinbeck High School, and over the years he has been a basketball coach several times as well as the math department head. Data will be collected in his Math 2 class which is also composed of mostly 10<sup>th</sup> grade students.

## **Data Collection Procedures**

### **Intervention.**

As this study sought to observe and analyze what happens in the classroom under normal conditions, it was non-experimental in nature and did not introduce a new variable or intervention. It was hoped that the researcher would be observing the classes under the conditions they would normally operate under outside of the study. Rather than comparing different classes with each other, the study compared the activity, responses, and performance of

the female and male math students. So, the variable in this study was simply be the gender of the students themselves and not any newly introduced technique or stimulus.

### **Implementation.**

- a) In preparation for the collection of data, the permission of the principal and cooperating teachers was sought out initially. The author visited each class approximately two weeks prior to the data collection period to introduce himself and the study to the class, and at this time, permission forms (see Appendix A) were sent home with the students.
- b) To record the frequency of dialogue in relation to gender, data collection forms were created (see Appendix B). Rather than analyze video or audio recordings, this study attempted to manually collect data on the frequency of speech with a clipboard using coding notation and the data collection forms. The form included the time period, type of learning activity, space for marking the gender when comments are made, and space for recording other types of pertinent information. Besides frequency, the author attempted to record for each utterance not just the gender but also used codes to mark whether it was a question or comment as well as other features such as if they raised their hand or not. The study attempted to record all potentially relevant data, so a significant portion of the form was devoted to more unstructured recording like the need to note when the author witnessed any of the commonly identifiable inequitable teacher-student interactions discussed in the theoretical framework section of this paper.
- c) After five days of collecting the aforementioned type of data in each class, the author visited each class once again to administer an affective survey. The survey, called Who and Mathematics, was a Likert-style survey that asked the students to rate themselves on a scale of 1-5 corresponding to response categories ranging from “Boys definitely more

than girls” to “Girls definitely more than boys.” It included items such as, “Find mathematics difficult,” and, “Mathematics is their favorite subject” (See Appendix C).

- d) Each of the four participating teachers was interviewed following the observation period. The goal of the interviews was to investigate to what extent and how the teachers take gender into account in their practices. Specifically, they were questioned regarding how gender comes into play in their arranging of the seating of students, the forming of groups and pairs, and selecting students for questioning and participation.

## **Data Collection and Sources**

### **Quantitative data.**

- Frequency data: The main source of quantitative data was the recording of the frequency of classroom commentary as it relates to gender. The data collection sheets kept track of how often the boys were speaking and how often the girls were speaking in math class for as much of each period as possible.
- Surveys: A 30-item Likert-style survey was chosen and administered to gauge the students’ attitudes, beliefs, and feelings about math. The survey was adapted from one of the most commonly given surveys regarding attitudes and mathematics, the Fennema-Sherman Mathematics Attitude Scales. Rather than the nine assessment categories of the Fennema-Sherman Mathematics Attitudes Scales, this survey used six categories, similar to the Attitudes Toward Mathematics Inventory developed by Tapia and Marsh.

Coincidentally, not only did Fennema help write one of the most popularly used affective math surveys, she is also a prominent publisher of research regarding the gender gap in math. As the survey does include a 1-5 scale, in some sense it can be considered



quantitative. However, as these types of affective questions are so inherently subjective, the survey is being used more as a qualitative source of data in this study.

### **Qualitative data.**

- Descriptive notes: The data collection sheets not only recorded the frequency data but also notes regarding the events that unfolded during observation. If male students were dominating the task formulation or real-world discussions, if failures were masked or emphasized, if teachers spoke to students in argumentative vs. authoritative fashions - these were all noted on the data collection sheets. The sheets included any and all information witnessed that may have been pertinent to the study. Immediately following each observation, the author reviewed the recorded notes and added any further reflections or information it was not possible to write down during the observation period.
- Surveys: The survey sought to get some sense of how the students feel about math. It attempted to gauge how the students see their own abilities in math, whether they like math or not, whether they might consider a career or course of study in math, as well as other affective measures such as usefulness.
- Interviews: The teacher interviews provided key data regarding the actual practices of current teachers in the field. This is important for learning how to modify future practices to create greater gender equity.

### **Data Collectors**

All Data will be collected by the author.

## **Data Analysis**

### **Quantitative data.**

- Frequency data: The frequency data will be used in an attempt to see if either gender is dominating the discussion in the classroom and during what type of learning activities. If one gender is speaking a lot more than the other, it can be hypothesized that the more vocal students are getting more out of the experience. Previous research has consistently shown that male students speak more in math class. This study seeks to add to this research by discovering if this trend still continues.
- Surveys: The scores provided by the 1-5 scales will be collected and analyzed. The study will be looking at the average scores overall between female and male students and at the average scores for each question as they relate to gender.

### **Qualitative data.**

- Descriptive notes: The data collection sheets from each day of observation will be analyzed, looking for any instances of or trends in inequitable teacher-student or student-student interactions. The sheets will be coded in analysis depending on the type of interaction in hopes of finding any trends in common types of interactions or interactions that seem to frequently occur during the same type of learning activity. It may or may not be found that activity-types and inequitable interaction-types correlate. At the least, it will be shown which interaction-types happen more frequently than others.
- Surveys: The survey responses were reflected on as they relate to gender. This will be done for each question. The surveys will not just be averaged quantitatively; student responses will also be coded in regards to the six assessment categories: confidence, anxiety, value, enjoyment, motivation, and parent/teacher expectations.

- Interviews: The survey data was scanned for evidence of specific practices of the various teachers that may have been creating a more equitable situation in their classroom.

### **All data.**

The results of both the quantitative and qualitative data will be used to answer the research question.

### **Limitations**

#### **Implementation fidelity.**

The study relies on handmade recordings of interactions. Clearly, the author will not perfectly record every interaction on every day correctly using this technique. As this is the only possible way to record classroom discourse at Steinbeck High School, the author will address this weakness by becoming very familiar with quickly written shorthand notation as well as run some practice sessions doing it. Also, this has been addressed by limiting the recording of certain types of learning activities where this is more feasible.

#### **Experimenter bias.**

As the other teacher participants are the author's colleagues, the author may be more reluctant to identify his colleagues practicing discriminatory behavior. He may have more of a "blind eye" to their inequitable interactions if he has established personal relationships with the teachers as opposed to if he was observing the classrooms of strangers. The author will address this by keeping all recorded notes private and never coded with the participating teachers' names.

**Scale.**

This study was limited to one high school and might not be representative of what happens at other schools. Only four classes were utilized with a little over a hundred students. This sample size could make some question whether the results of the study are universally applicable. The scale issue was addressed in the initial design of the study – the author chose as big of a sample size as was practically possible and readily available.

**Lack of video or audio.**

The study could have been stronger had there been the possibility of video or audio recording. Then, not only would the researcher not miss anything as it can be re-winded, but data could also have been taken during the parts of the class period when multiple people are talking at once. Through multiple views or listens, the researcher can glean information about what multiple groups are doing at the same time. While possibly not the ideal, the hand recording technique was the only method that would be allowable under the policies of Steinbeck High School, so the study has to rely on as much data as it can get under the given conditions.

## **Chapter 4: Findings**

The goal of this research was to gauge the current state of the gender gap while investigating through a classroom study what steps might be taken by teachers to promote gender equity in their classrooms. While the review of the literature illustrated that there is still progress to be made on the issue of math gender gaps, the action research portion of the study was instrumental in finding practical information that may be useful to teachers looking to maximize gender equity. The classroom study made the following overall findings:

- The observation portion of the study found that neither sex dominated the discussion in the classroom. In some classes, females were observed speaking most of the time; in some classes, males were speaking most of the time, and in some classes neither males nor females were recorded to have more dialogue (See Appendix C).
- The survey found that the overwhelming majority of students saw no difference in the learning of math as it relates to gender. Most of those who did see a difference rated female students as being better at math (See Appendix E).
- The interviews showed that while most if not all teachers believe that gender equity is important, what they actually do in their practices to maximize it varies widely from teacher to teacher.

### **Classroom Observation Study**

While studies of the past have typically shown male students doing the majority of the talking in math class, this observational study found different results in each of the classes studied and more female students speaking overall in three of the four classes (see Appendix C).

In Teacher A's class, the males were found to be speaking more at a rate of 70% (See Figure C2). This may be related to the fact that she relies heavily on a call-and-response style of class discussion. Students are rarely if ever called on and mostly volunteer. There are also slightly more males enrolled in the class as it is 60% male and 40% female.

Teacher B's class, where discussion is mostly stifled, had the exact opposite results with females speaking 70% of the time (See Figure C3). Teacher B also relies mostly on volunteers. His class is seated in rows, and he teaches mainly through direct instruction. The same few female students who sit in the center of the class answered the overwhelming majority of requests for participation from the teacher.

Teacher C's class is seated in groups, similar to that of Teacher A. She has about an equal amount of cross-sex and same-sex groups. The class is taught in a group and whole-class discussion format with very little if any direct instruction. In Teacher C's class, the females were more frequent speakers during learning activities at a rate of 73% compared to the males at 27% (See Figure C4). As with Teacher A's class, this may be explained by the class enrollment - her class is made up of two-thirds female students and one-third male students.

In Teacher D's class, male and female comments were recorded at a roughly equal frequency. The observational study found females speaking 54% of the time and males speaking 46% of the time in this class (See Figure C5). Again, enrollment may likely be a factor in these numbers as the class is exactly 50% male and 50% female.

In all of the classes, the amount of speaking by each gender seemed more related to whether there were more males or females enrolled in the class and how the learning activities were structured as opposed to one sex or the other trying to dominate the discussion. So, while

the frequency data found were promising in that they showed a healthy mixture of female and male dialogue as opposed to the male-skewed data researchers have found in the past, other than that, they were somewhat inconclusive.

This might seem disappointing, but fortunately other useful data was collected during the observation besides the dialogue frequency data. Also, this was not a surprise as the consensus among modern researchers of discourse is that little can be gained from a simple frequency analysis. A proper discourse study should include as large a variety of data types as possible (Sauntson, 2012).

Possibly more valuable than the dialogue frequency data was the informal data collected during the observation. Although it did not show in the frequency data, there were a few occurrences of one gender or the other taking over the discussion in the class. In Teacher A's classroom there was one male student who made very frequent questions and contributions. He would often interrupt if others attempted to add to the discussion. In Teacher B's class, the same group of female students would answer almost all of the call-and-response questions on a daily basis. They would compete to answer the questions faster than one another and had created an atmosphere where the rest of the class would passively let them do this. These one-sided situations were certainly stemming from the structure of the class. In both of these classes, students were never called on in an organized fashion. They were always allowed to call out or volunteer answers. While likely unaware, it seems that the teachers had let these situations manifest over time.

While this observational study looked for evidence of the five types of inequitable interactions mentioned previously, only one of the types was observed. It happened with the

male student from Teacher A's class who was mentioned above as dominating the class discussion. It was observed at least two times that he made a mistake in his answer that was subsequently played down by the teacher. She made the mistake seem insignificant and seemingly helped the student salvage some respect in the eyes of the class. This was an example of the inequitable interaction that Jungwirth calls "the Concealing of Failure in the Teacher-Boys Interaction."

Another finding during the observation was related to encouraging or discouraging comments. In three out of four classes, there were multiple instances of female students calling out discouraging comments such as, "I'm going to fail the test" or "This is hard". The male students were not observed making these types of statements. In fact, the males were observed in two of the classes making confident outcries such as, "I'm going to ace the test" or "This is easy". It was somewhat striking that only males were observed making these type of courageous remarks and only females making the other type.

### **Student Surveys**

The survey was given to a roughly equal mix of female and male students with 59 female students and 49 male students participating for a total of 108 surveys. The results were very promising in regards to gender equity. Each item received one to five points. "Definitely Boys" got one point, "Probably Boys" got two points, "No Difference" got three points, "Probably Girls" got four points, and "Definitely Girls" got five points. Almost every item on the survey had a mean rating near three (See Appendix E). So, for all but a few of the items, students on average said that there was "No Difference" between males and females. The only items that were skewed toward the males were negative statements about needing help and teasing or distracting other students. Between ten and twenty percent of students in each class gave every



item on the survey a score of three or "No Difference". This fits with the promising results that Leder and Forgasz, the creators of the survey, share in their Australian studies (Leder&Forgasz, 2002). Compared to how these items have been scored on the MAS in past decades, there has been a huge amount of progress in students' perceptions of and feelings surrounding mathematics. Rather than seeing math as a male domain, this has shifted to the point where most of the students surveyed today see math as a neutral domain with the majority of those who do not actually viewing it as more of a female domain. A couple of the items in particular illustrate this shift. For the item "Need help in mathematics", 48% responded "No Difference", but out of the other 52% that responded that it did make a difference, 88% of those said males need more help (See Figure F1). Another example is the item "Get on with their work in class". Forty-six percent of students responded there was no difference, but of the 54% that claimed there was, 95% said girls are more likely to get on with their work (See Figure F2).

The comments at the end of the surveys were insightful and agreed with some of the aforementioned findings. Many students wrote that the survey did not make sense or was confusing because there really is no difference between boys and girls in any of the items. A few said it depended more of the particular student and not just their gender. This fit well with the results of the survey showing an overall opinion of no difference. A couple of female students mentioned that boys are more comfortable to ask questions in class and girls are more likely to consult their neighbors. This was noted anecdotally during the observation and showed another sign of progress to be made in the classroom environment, similar to the encouraging and discouraging comments observed. A few comments from the female students fit well with research that shows female students put in more effort and are receiving higher grades at the high

school level; they wrote comments on the survey such as "girls try a bit harder at school and home" and "girls have more strategy than boys".

### **Teacher Interviews**

The teacher interviews gave some sense of to what extent the four observed teachers take gender into account during their daily practices. The teachers were asked about how they seated students, how they grouped students, and how they called on students for participation.

Teacher A said that when she forms her groups, she makes an attempt to have mostly cross-sex groups. However, she admitted that most of the time, she lets the students form their own groups. She said that when she forms the groups, students will simply change the groups on their own and mostly go with their friends anyway. This may be explained by the fact that her class is composed of upperclassmen who are a bit more independent. She arranges the seating in a cross-sex fashion initially, but again, the students will move seats to partner with those of the same sex. During class discussions and asking questions, students are allowed to call out responses on a volunteer basis. Rarely if ever are students specifically called on. So, she had groups, but they were mostly unstructured, and most if not all participation was volunteered by the students.

Teacher B considers cross-sex groups to be a behavior management problem. As such, he arranges the seating so that there are same-sex blocks of students that can group together. Although he claims to use partners and groups from time to time, only independent and whole class learning formats were seen during the observation period. Teacher A also claimed to occasionally call on specific students, but this too was not witnessed during the observations. All questions answered and comments made during the observation were called out or volunteered

by the students. Teacher B had groups outlined on a seating chart, but they were not seen being used at all during the observation, and they were also intentionally same-sex.

The third teacher, Teacher C, had her students permanently seated in groups, most all of which were intentionally cross-sex. She said she did have to make a single same-sex group from time to time due to behavioral concerns. Groups were frequently called on for answers or to come to the board in this class. However, rarely was a specific student called on to participate – she said she normally calls on a specific group, and then the group decides who to choose as their representative.

Like Teacher C, Teacher D had his whole class in permanent groups that were intentionally cross-sex. He also had the same situation of occasionally needing to have a single same-sex group of boys who due to their behavior only seemed to work well with other boys. Specific students were called to the board or called on to answer questions in this class. The teacher always chose the student and was never observed taking volunteers. He did a nice job of switching back and forth between male and female students. In the interview, he said this was done intentionally in an attempt to hear from all voices in the classroom.

While all of the teachers said that gender equity is important to them and that they definitely incorporate it into their practices, the extent to which they have successfully done this seems to vary. The unstructured learning activities of Teacher A and the direct instruction, traditional style of Teacher B both allow for one gender or the other to take over the class discussion. When students are encouraged to call out answers at will, it is easier for the situation to become unbalanced. These two classes also use groups less frequently, so not as many class members are engaged in the learning activities.

## **Chapter 5: Conclusion**

In order to gain a sense of the current state of the math gender gap and some insight into what steps educators, students, and the public can take to maximize gender equity in the learning of mathematics, a comprehensive review of the literature was done as well as a three-part study of four American high school classrooms. The literature on math gender gaps shows a progression in the understanding of what causes and perpetuates them as well as some gains over the last few decades in closing up some of the previously measured gaps. The classroom study found that while there is a small amount of evidence of gender inequity here and there, students are participating in math class at fairly equal rates and teachers are to various degrees actively taking gender equity into account in their practices. The student survey showed an overwhelming majority of students see math as a gender-neutral domain.

### **Looking at the Research on Gender Gaps**

Some common threads were found among the research in the field of math gender gaps that are worth mentioning. The first has to do with their being biological differences between females and males. While it is true that there are cognitive differences between the sexes, the potential for learning is not affected by these differences, regardless of subject. Many of the authors reviewed as well as all of the teachers who participated in the study express the idea that while female and male students may think differently, they can both achieve at the highest levels of math. It is the effort that the student puts forth that makes the real difference. The idea that males are genetically pre-disposed to be better at math is outdated and needs to be left in the past. It justifies the gender gap and takes away from the quest to find its true roots.

A wealth of information was found reading these root causes, and research continues to be done in this area. Researchers such as Dee and Bailey point to a complex collection of various social factors that are at play behind keeping the gender gap alive. Bailey's *differential socialization theory*, an outgrowth of the earlier social theories of Vygotsky and Bandura, compares the array of factors to the keys of a piano. The inter-related factors are all at play simultaneously, and only with solid research can the various keys be sorted out and distinguished from the others. If educators, students, and the public wish to positively affect the gender gap in math, then they should think about the various ways in which they might have influence over the females in their lives. Female students should be encouraged by their families, educators, and the media to pursue studies in the STEM fields. This is already happening to some extent with a variety of female recruitment programs being introduced.

### **Insights from the Classroom Research Study**

The three part classroom study was motivated by the fact that many gender gap studies are based solely on standardized test data and provide little if any practical information for educators and the public. A number of revelations were made regarding the gender gap. The recording of the frequency of dialogue showed that female and male students both had active, equal voices in the classroom. The data show promising results as female and male students were recorded to be speaking at roughly equal frequencies overall - neither one had a dominant voice.

The observation part of the study brought to light one of the most significant findings. While reflecting on the performance of the classes, it was noticed that Teachers C and D seemed to have significantly greater situations of gender equity in their classrooms. Their discussions were more balanced by gender and significantly more students participated overall in those

classes. Upon examination, it was noticed that in these classes, the teachers are far more in control of how and when students participate. They intentionally select students instead of taking volunteers or using call-and-response. They also use groups exclusively. Both teachers mentioned in the interviews that they spend a lot of time designing the groups and that gender is one of the main concerns when doing so. Their main goal was not just to balance participation in regards to gender but to go even further by attempting to hear from all voices in the classroom on a regular basis. The time they spend designing groups certainly seems to be paying off in terms of the gender equity observed in their classrooms.

In the interviews, all of the teachers said they are concerned with gender equity and that they take it into account when making seating arrangements, when partnering students, and when selecting students for participation. Despite this agreement, various levels of gender equity were found in their classrooms. Teachers who let students select their own partners or volunteer answers or comments without being called on seemed to have a lesser degree of gender equity in their classrooms. The classes with a higher degree of equity were those in which the teachers continually took charge of selecting who work answer or participate. They spent much more time in the designing of their groups and used them every day as the main learning mode. How the teachers design the groups was quite interesting. They both said that the groups are designed by ability first - the groups are balanced between high, medium, and low skill levels. Then, gender is taken into account. Both teachers also mentioned other factors that were equally as important such as personality and communication skills.

The survey data was extremely promising as it showed a large majority of the students see no difference in regards to gender and learning math. Even more of a break from past trends, those that do not see it as neutral tend to view math as a female domain. Although this has been

shown previously in the results of Leder and Forgasz, it was interesting to find the same results with American students.

## **Conclusion**

It is hoped that the first part of this study, the extensive review of the existing literature, will help bring educators and the public up to date on the complex issue of the gender gap in math. The findings here call for more studies that use actual classroom data rather than test scores and more studies that look not into the sizes of the gaps only but try to look deeper into the root causes of the gaps at hand.

The current focus by education and the government on STEM programs has reinvigorated the gender gap discussion as society is reminded that the gaps in math and science at the college and career level have not been shrinking nearly as quickly as those in primary and secondary schools. While this is positive for advocates of gender equity, there is a fear that as more promising stories surface of gaps shrinking and closing, the public will lose sight of these larger gaps at the higher levels.

This study finds that the gender gap can still be witnessed in small ways in the classrooms of today, although the teachers do actively try to balance their classes in terms of gender. Likely the largest contribution of this study is that some concrete practices were identified among teachers that were shown to enhance gender equity. First, the heavy use of a group format as opposed to rows and direct instruction was beneficial. Second, teachers can create more balance by specifically calling on students rather than using call-and-response or asking for volunteers. Third, through careful design of groups and pairings, teachers can ensure

that they maximize the number of voices heard in their classroom while simultaneously maximizing the learning experience for their students.

While the gender gap in math has come a long way, teachers need to remain vigilant to make sure that we continue to move toward a situation of greater gender equity for all.



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## Appendix A: Permission Form



CALIFORNIA STATE UNIVERSITY  
Monterey Bay

100 Campus Center  
Seaside, CA 93955-8001

### PARENTAL/LEGAL GUARDIAN CONSENT FOR MINOR TO PARTICIPATE IN RESEARCH

**PROJECT TITLE:** Analyzing Participation In the Mathematics Classroom

We would like your child to participate in a research study conducted by one of our math teachers, Ryan Sullivan, to be used for collecting data that will be included in a Master's thesis at California State University, Monterey Bay (CSUMB).

The purpose of this research is to attempt to establish a relationship between rates of participation and achievement in math class.

Your child was selected as a participant in this study because he/she is a current high school math student.

The benefits of your child's participation in this project include learning about how research is conducted, learning about the results of the study, and helping other teachers improve their practices.

If you decide to allow your child to participate in this research, he/she will be asked to have their class observed by Mr. Sullivan for a period of one week. Following the observation, the students will be asked to complete a survey.

Any information that is obtained in connection with this study and that can be identified with your child will remain confidential and will only be disclosed with your written or witnessed verbal permission or as required by law. Student names will not be recorded as part of the study, and your student will remain completely anonymous.

Allowing your child to take part in this project is entirely up to you. You can choose whether or not to allow your child to participate. If you consent to your child's participation in this study, you may withdraw that consent at any time without consequences of any kind. Your child may also refuse to answer any questions he/she does not want to answer and still remain in the study. The investigator may withdraw your child from this research if circumstances arise which warrant doing so.

If you want to know more about this research project or have questions or concerns, please contact faculty advisor Mark O'Shea in the CSUMB Teacher education Department at (831) 582-3039 or [moshea@csumb.edu](mailto:moshea@csumb.edu).

The project has been reviewed and accepted by the Committee for Protection of Human Subjects (CPHS) California State University Monterey Bay's review board for research involving humans as subjects. You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study.

If you have questions about CSUMB's guidelines and policies for human subject research, they're posted online at: <http://spo.csumb.edu/guidelines>. To speak with someone about human subjects, please contact the CPHS Chair, Dr. Chip Lenno, at (831) 582-4700, [clenno@csumb.edu](mailto:clenno@csumb.edu), or in person at CSU Monterey Bay, 100 Campus Center, Media Learning Center (Building 18), Seaside CA 93955.

You will get a copy of this consent form. Thank you for considering participation.

Sincerely,  
Ryan Sullivan, SHS Math Teacher

**CSUMB** not **EDU**

The California State University

Bakersfield • Channel Islands • Chico • Dominguez Hills • Fresno • Fullerton • Hayward • Humboldt • Long Beach • Los Angeles • Maritime Academy • Monterey Bay • Northridge • Pomona • Sacramento • San Bernardino • San Diego • San Francisco • San Jose • San Luis Obispo • San Marcos • Sonoma • Stanislaus

## Appendix B: Data Collection Form



Class:      A   B   C   D      Date:

Format	Teacher-Student	Student-Student	Notes
<input type="checkbox"/> Procedural <input type="checkbox"/> Lecture <input type="checkbox"/> Coop. Group Work <input type="checkbox"/> Ind. Practice <input type="checkbox"/> Other _____			
<input type="checkbox"/> Procedural <input type="checkbox"/> Lecture <input type="checkbox"/> Coop. Group Work <input type="checkbox"/> Ind. Practice <input type="checkbox"/> Other _____			
<input type="checkbox"/> Procedural <input type="checkbox"/> Lecture <input type="checkbox"/> Coop. Group Work <input type="checkbox"/> Ind. Practice <input type="checkbox"/> Other _____			

Automated Learning Behaviors:

Blocking Task Constitution:

Blocking Reference to Outside Knowledge:

Too Complete Description:

Concealing/Emerging of Failure:

Argumentative/Authoritative Insistence:

## Appendix C: Frequency of Recorded Classroom Dialogue

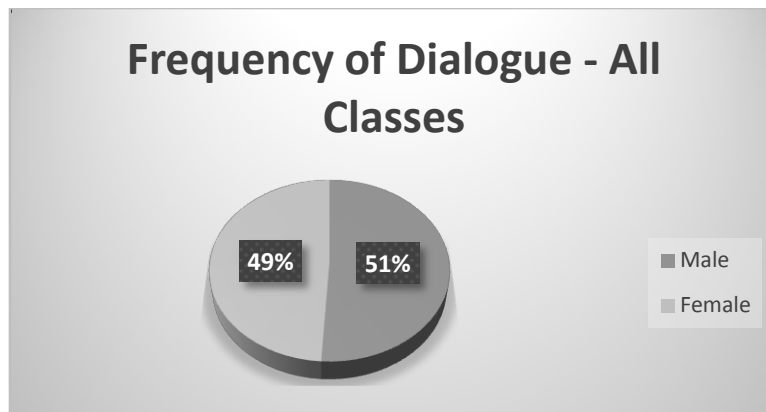


Figure C1. Frequency of Dialogue - All Classes

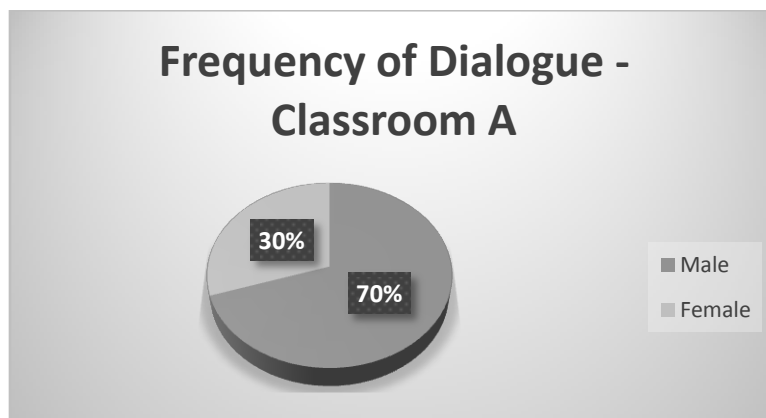


Figure C2. Frequency of Dialogue - Classroom A

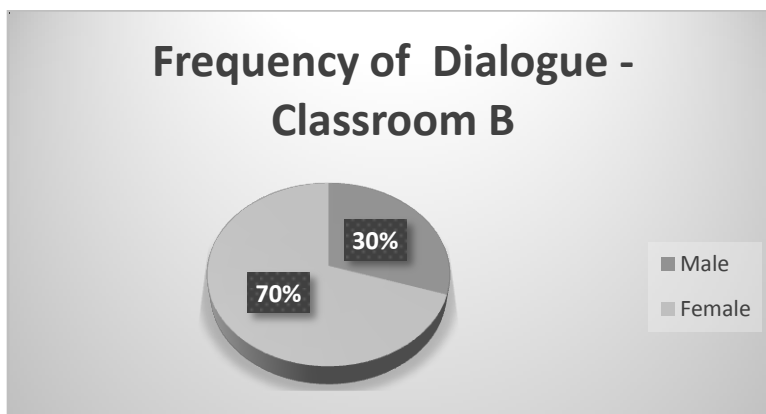


Figure C3. Frequency of Dialogue - Classroom B

## Appendix C: Frequency of Recorded Classroom Dialogue

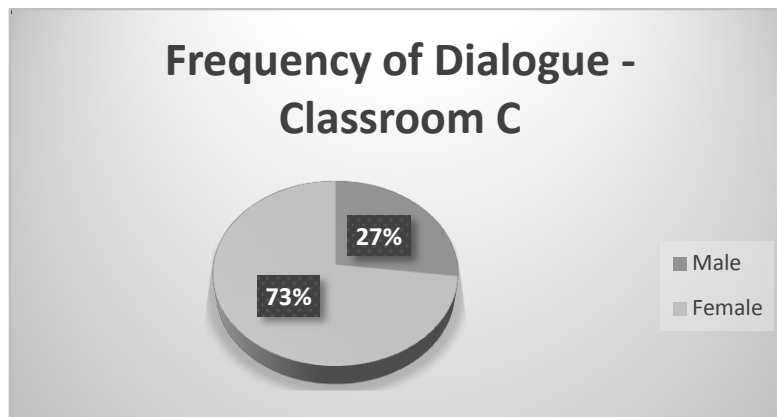


Figure C4. Frequency of Dialogue - Classroom C

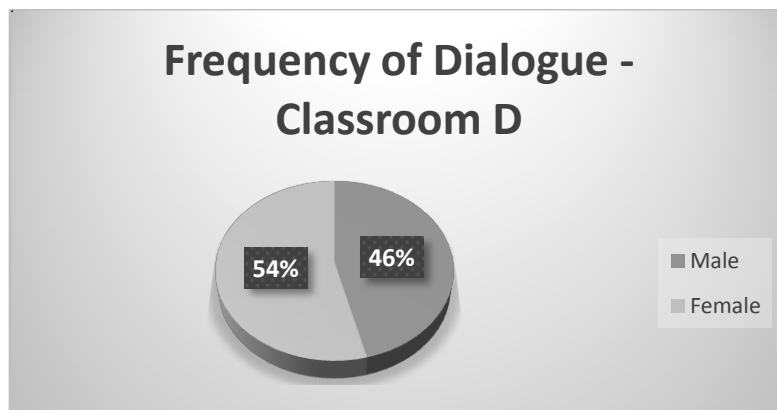


Figure C5. Frequency of Dialogue - Classroom D



## Appendix D: Who and Mathematics Survey – Page 1 of 3

### WHO AND MATHEMATICS

The purpose of this survey is to find out your opinion about a number of statements related to boys' and girls' learning of mathematics. There are no correct or incorrect answers. We are only interested in your personal opinion.

The survey should take about 10-15 minutes to complete.

Please fill in the following information before answering the survey questions.

*School* .....

Please circle your responses to the following:

*Gender:*        Female / Male

*Grade Level:*    7 / 8 / 9 / 10

*How good are you at mathematics?*        Excellent / good / average / below average / weak

*Do you plan to study mathematics in your last of year of secondary school?*    Yes / No / Unsure

At the end of the survey we have left a space for comments. We would value your feedback about any statements that you find confusing, unclear, contain words that you do not understand or are inappropriate in some other way. To make it easier for you, the statements have been numbered.

### INSTRUCTIONS

For *each* item, you are asked to circle **ONE** of the following responses

**BD = BOYS DEFINITELY** more likely than girls

**BP = BOYS PROBABLY** more likely than girls

**ND = NO DIFFERENCE** between boys and girls

**GP = GIRLS PROBABLY** more likely than boys

**GD = GIRLS DEFINITELY** more likely than boys

#### PRACTICE STATEMENT

0. Dislike mathematics

**BD   BP   ND   GP   GD**

If you think that *boys are probably more likely than girls* to dislike mathematics, you would circle **BP**

**PLEASE TURN TO NEXT PAGE**

## Appendix D: Who and Mathematics Survey – Page 2 of 3

Answer each question as *quickly* as you can. If you change your mind about an answer, just cross it out and circle another one.

- |    |   |           |           |           |           |           |
|----|---|-----------|-----------|-----------|-----------|-----------|
| 1  | Mathematics is their favorite subject                                     | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 2  | Think it is important to understand the work in mathematics               | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 3  | Are asked more questions by the mathematics teacher                       | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 4  | Give up when they find a mathematics problem is too difficult             | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 5  | Have to work hard in mathematics to do well                               | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 6  | Enjoy mathematics   | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 7  | Care about doing well in mathematics                                      | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 8  | Think they did not work hard enough if they do not do well in mathematics | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 9  | Parents would be disappointed if they did not do well in mathematics      | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 10 | Need mathematics to maximize future employment opportunities              | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 11 | Like challenging mathematics problems                                     | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 12 | Are encouraged to do well by the mathematics teacher                      | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 13 | Mathematics teachers think they will do well                              | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 14 | Think mathematics will be important in their adult life                   | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 15 | Expect to do well in mathematics  | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 16 | Distract other students from their mathematics work                       | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 17 | Get the wrong answers in mathematics                                      | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 18 | Find mathematics easy   | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 19 | Parents think it is important for them to study mathematics               | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 20 | Need more help in mathematics   | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 21 | Tease boys if they are good at mathematics                                | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 22 | Worry if they do not do well in mathematics                               | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 23 | Are not good at mathematics   | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |
| 24 | Like using computers to work on mathematics problems                      | <b>BD</b> | <b>BP</b> | <b>ND</b> | <b>GP</b> | <b>GD</b> |

## Appendix D: Who and Mathematics Survey – Page 3 of 3

25	Mathematics teachers spend more time with them	BD	BP	ND	GP	GD
26	Consider mathematics to be boring	BD	BP	ND	GP	GD
27	Find mathematics difficult	BD	BP	ND	GP	GD
28	Get on with their work in class	BD	BP	ND	GP	GD
29	Think mathematics is interesting	BD	BP	ND	GP	GD
30	Tease girls if they are good at mathematics	BD	BP	ND	GP	GD

### Comments?

.....

.....

.....

.....

.....

.....

**THANK YOU FOR TAKING PART IN THIS PROJECT**

## Appendix E: Means and Standard Deviations for Survey Items

Item	Mean	SD
1. Mathematics is their favorite subject	3.14	.65
2. Think it is important to understand the work in mathematics	3.25	.69
3. Are asked more questions by the mathematics teacher	3.21	1.01
4. Give up when they find a mathematics problem is too difficult	2.50	.89
5. Have to work hard in mathematics to do well	2.78	.85
6. Enjoy mathematics	3.33	.75
7. Care about doing well in mathematics	3.63	.76
8. Think they did not work hard enough if they did not do well in mathematics	3.35	.90
9. Parents would be disappointed if they do not do well in mathematics	3.09	.85
10. Need mathematics to maximize future employment opportunities	2.72	.73
11. Like challenging mathematics problems	3.11	.86
12. Are encouraged to do well by the mathematics teacher	3.01	.70
13. Mathematics teacher thinks they will do well	3.31	.82
14. Think mathematics will be important in their adult life	3.06	.78
15. Expect to do well in mathematics	3.19	.95
16. Distract other students from their mathematics work	1.87	.93
17. Get the wrong answers in mathematics	2.70	.70
18. Find mathematics easy	3.30	.81
19. Parents think it is important for them to study mathematics	2.94	.50
20. Need more help in mathematics	2.56	.69
21. Tease boys if they are good at mathematics	2.82	1.16
22. Worry if they do not do well in mathematics	3.36	.84
23. Are not good at mathematics	2.77	.68
24. Like using computers to work on mathematics problems	2.83	.67
25. Mathematics teachers spend more time with them	2.94	.80
26. Consider mathematics to be boring	2.46	.86
27. Find mathematics difficult	2.67	.68
28. Get on with their work in class	3.60	.74
29. Think mathematics is interesting	3.19	.72
30. Tease girls if they are good at mathematics	2.51	1.01

## Appendix F: Responses to Survey Items 20 and 28

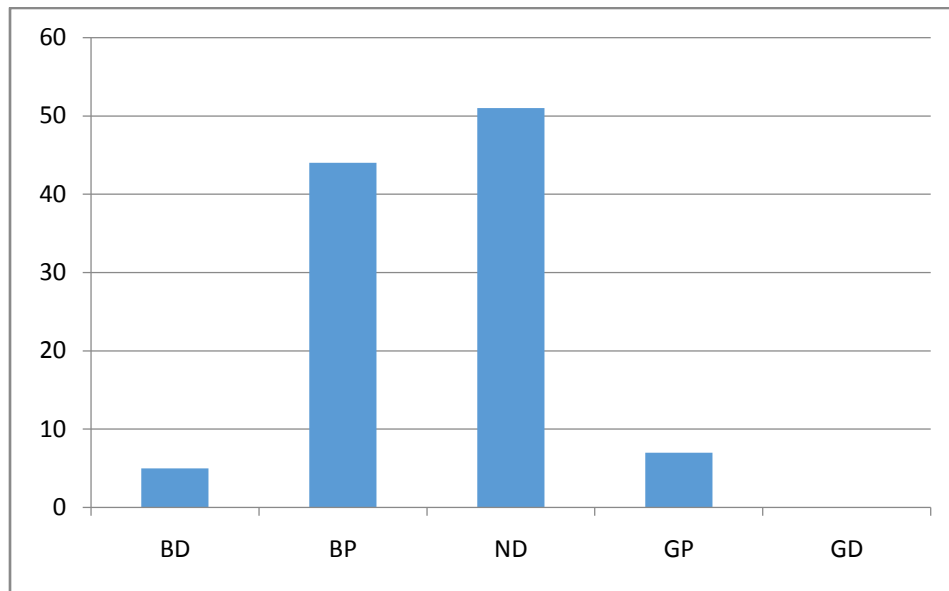


Figure 1. Survey Item 20 "Need more help in mathematics"

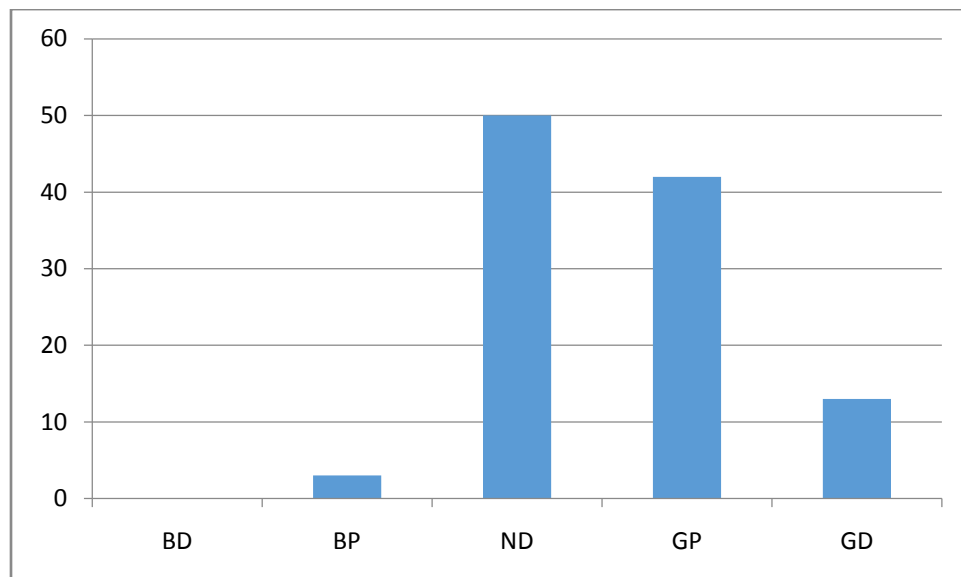


Figure 2. Survey Item 28 "Get on with their work in class"